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THE EFFECTIVENESS OF GOVERNMENT INITIATIVES IN ENERGY CONSERVATION

by

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The Effectiveness of Government Initiatives in Energy Conservation

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Abstract

Energy policy in the US is characterized by two motivations: to stem the flow of currency to the oil producing nations, and to prevent energy prices rising as much as it is now being feared they will. Conservation has been seized upon as a principal initiative, and the two most important components of present policy are the investment tax credit and energy taxes.

The investment tax credit is aimed toward improving the way energy is used without raising the price. It lowers the price of capital relative to energy for applications where there is a tradeoff. But this measure is working against the current of wider taxation measures which stimulate energy growth through lowering the price of capital and raising the price of labor, thus encouraging investment in energy intensive equipment to substitute for labor. The conservation investment tax credit does not reverse this trend. Nor does it have a significant effect in raising the rate of return on an investment in conservation, which is dominated by the energy savings and the expected inflation in energy prices. In summary, it appears that the tax credit will have difficulty achieving the goals set for it. An encouragement of activities that conserve or substitute for energy by promoting employment rather than extra capital investment is necessary.

In a society, which has been built on low cost energy, taxation measures which increase the price of energy are both unpopular and disruptive. But higher prices are inevitable and the rise is likely to be rapid after 1985. Recession both in the US and throughout the world is very likely. A policy of phasing in higher prices through taxes will enable the economic and social effects to be monitored and will encourage the necessary new technologies.

1. Conservation and Energy Policy

1.1 Introduction

There have been several major studies completed in recent months[1,2] which indicate that, by the mid 1980's, there will be strong upward pressure on the world price for oil. This is caused by the continuing growth of demand reducing the current surplus production capacity of the Organization of Petroleum Exporting Countries (OPEC) to the point where there is a potential shortfall. The competition for supplies that would follow is likely to cause economic hardship and deep recession in the U.S. and around the world.

Energy policy in the U.S. may be summed up in a single phrase: the desire to prevent energy prices rising as much as the government thinks they might. A strategy that has been seized upon is to reduce the growth in demand through conservation.

This paper is an exploration of the issues involved in government stimulation of energy conservation. It classifies and evaluates the main policy tools that are available to a government, and explores how consumers (homeowners and businesses) might respond to those initiatives.

There is no doubt that energy conservation is a widely debated--and widely misunderstood--phenomenon. Attitudes cover the full spectrum from that of the laissez faire market to a fundamental change in lifestyle suggested by some environmentalist groups. New ways of looking at the efficiency of energy use have been proposed by the American Physical Society[3] when they invoke the second law of thermodynamics to show that the absolute efficiency of energy use is very low. Conservation spending is the most rapidly growing area of the Department of Energy Budget, and is called a "cornerstone" of the 1977 National Energy Plan (NEP).[4] The latter provides for billions of dollars to be paid to householders and business to assist them in reducing energy waste. Is this money well spent? Or are the trends toward more efficient energy use as a response to higher prices already well-established? If the conservation response is not rapid enough, in the view of the government, what can be done to accelerate it?

1.2 The Place of Conservation in the National Energy Plan

The opening words of Chapter IV of the NEP are "the cornerstone of the National Energy Plan is conservation, the cleanest and cheapest source of new energy supply". Of the seven goals of the program, five were to do with conservation and the other two were concerned with the switch to coal and the strategic oil reserve.

Why the emphasis on conservation? Two main reasons were given. The first was the political problem caused by a large and growing dependence on imported oil from a cartel not wholly sympathetic to U.S. foreign policy. The second reason was a concern that the high rate of growth of oil consumption cannot be sustained. The problem was articulated as not 'actual physical exhaustion of oil resources' but rather 'the price of oil becoming prohibitive for most energy uses' as more expensive recovery methods and novel techniques were used to produce additional oil. Conservation in the Plan is viewed as contributing to international stability by moderating the growing pressure on world oil resources. It is stated that "if conservation is delayed until world oil production approaches its capacity limitation, it will have to be carried out hastily under emergency conditions". Part of the NEP motivation for conservation, then, is the expectation of rapidly rising oil prices, and the desire to assist in their stabilization.

Another cogent reason for conservation of oil from the government's point of view is the strain on the balance of payments caused by a high oil price and increasing demand. Oil imports presently cost the U.S. $45 billion per year and this is viewed as an unacceptable burden by the Administration. Each day, the oil exporting countries earn about $150 million more than they spend overseas, and while much of this wealth is recycled through investment in the Western economies, there is a question about the long term stability of this arrangement. From the government's point of view of being concerned about foreign exchange, conservation has two attractions. It first reduces the need for the highest cost energy sources such as liquid natural gas and oil on the "spot" or short-term market. Secondly, it reduces the total need for imports, and hence the export of currency.

Energy policy in the U.S. in recent years has been characterized by a desire to prevent domestic oil and gas producers collecting "windfall" profits if the price of energy were to rise to world levels. So a costly regulatory program was instituted to ensure that "old" oil, discovered and exploited at a time when the price was, say, $3.50 per barrel, cannot be sold at the current world price of $13.50 per barrel. This program has had the effect of maintaining energy prices below the general world price.

In fact, the U.S. has a tradition of low priced energy, and it is this that contributes to the fundamental differences of opinion that are in evidence over the effectiveness of higher energy prices as a means of reducing demand. From the economic efficiency point of view, higher prices do induce consumers to cut back, although in the short term, response is limited. Also, new energy supply technologies, currently more expensive than oil, become competitive and enter the market. Once their use has begun, their unit costs are likely to fall because of mass production and movement down the 'learning curve'. For greatest economic efficiency in a competitive market, the basic theory is that price to the consumer should be the marginal cost, that is, the cost of supplying the last barrel of oil.

However, in the legislative environment, price is viewed as being only one tool in the government's bag. Rising energy prices can cause almost as many problems as they solve, including hardship for lower income groups, a pervasive effect on inflation and an unpredictable effect on economic activity and growth. A society that has been built around cheap energy will not change its habits quickly, and hitting it hard with higher prices may cause local damage as well as motion of the whole machine.

There is no question that prices must rise. Accompanying this rise will be a change in the way energy is used; an improvement in the capital structure giving greater efficiency and less energy intensity. A government, in trying to prevent the adverse effects of the higher prices would prefer the improvement in the capital structure to precede the price rise rather than to lag it. Its expectation from this would be that prices would, at least, appear to be under control, and would not rise so far as they might if they were causing the improvement in the capital structure. So another tool in the bag is to stimulate an improvement in the way energy is used without raising the price.

1.3 The Definition of Conservation

As the Workshop on Alternative Energy Strategies (WAES)[2] puts it, "the term conservation carries a thousand meanings for a thousand users". It vaguely connotes thrift, economy, efficiency. The WAES study adopted a "relatively restricted definition of energy conservation, - referring only to those actions and policies that increase the technical efficiency of energy use". However, the need to separate technical efficiencies from economic activities; i.e. policy initiatives from behavioral characteristics, was recognized; but because of the difficulties in decoupling the factors, it was not attempted.

The NEP used a broader definition which makes clear that both the technical and behavioral aspects are included. It defined conservation as "initiatives to reduce demand". The NEP notes that conservation measures do "sometimes involve sacrifice", but "these sacrifices need not result in major changes in the American way of life or in reduced standards of living". This definition thus goes considerably beyond the 1976 Energy Research and Development Administration (ERDA) definition which was "the introduction of technologies permitting a more efficient use of energy". ERDA was careful to exclude the behavioral aspects of consumption from its definition.

The definition of energy conservation that we shall use in this paper is "the reduction in growth of demand for energy achieved by measures deliberately adopted for that purpose". The measure would, of course, be adopted by the U.S. federal or local government; if OPEC unilaterally decided to raise energy prices for its own reasons, or if there were an international uranium cartel, our definition of conservation would not include consumer response to these dislocations.

Our definition would, however, include the taxing of oil by the U.S. government when this is done to shape the demand curve. Of course when energy is taxed, revenue accrues to the government, and the redistribution of this revenue is a vexed question. If the taxing is done merely to decrease demand, then it is not a fiscal measure and revenues should be returned to the public on a neutral basis (i.e. neither progressive or regressive). But in many countries which have always had to import oil, a second thought is not given to raising revenue through energy taxes. A car and its use was regarded as a luxury good in Britain at the turn of the century, and gasoline was taxed because it was "sinful".[5] In these cases it is not possible in practice to separate the modification of demand from the raising of government revenue.

This paper is more a tutorial on the conservation policy tools and their effectiveness rather than a detailed numerical analysis of the savings that can be expected in the U.S. under the particular conditions of the NEP. Such analysis requires an economic energy demand model capable of handling the policy initiatives, and there are some studies already extant.[6,7] A difficulty encountered in such analysis is outlined below because it impinges on the evaluation of the effectiveness of the measure.

In order to estimate how the demand for energy might change under conservation practices, it is necessary to extrapolate forward an unambiguous trend of demand that will serve as a base-line to evaluate the savings. This is not at all straightforward, as even the trend projection might reflect factors already operating to curb growth in energy consumption. There are policy measures already adopted or mandated for future adoption - for example upgraded Federal Housing Administration (FHA) insulation requirements, urban transportation, plans to comply with air quality controls or energy efficient labeling - that can, in a sense, be viewed as integral to trends already under way.

Darmstadter[8] states the position as follows. "To exclude such factors from a trend projection is to bias projected growth on the high side and, therefore, to set up a straw man insofar as it then enables one to demonstrate that potential payoffs of energy conservation would be large. On the other hand, to modify a trend projection by building in as many demand-dampening factors as we sense are already in progress or "waiting in the wings" would defeat the purpose of the exercise, which is to quantify the effect of stipulated conservation actions on bending the future demand curve." The procedure Darmstadter followed was to "project future developments as if they were unaffected by explicit demand-dampening tendencies". We adopt a similar point of view in this analysis, of attempting to separate those regulations or incentives perpetrated by government from the measurable response of consumers to higher energy prices in using less energy, both in the short and long term. This is done so the effectiveness of the government measures can be gauged.

2. The Relationship Between Energy, Capital, Labor, and Materials

2.1 The Substitution Between Factor Inputs

A guiding principle of the National Energy Plan is that it is "axiomatic that healthy economic growth should continue" and that full employment be promoted. As energy is one component or one "factor input" of the manufacturing process, it is evident that if output is to be sustained with less energy, then some other factor input must substitute for the energy that has been saved. To put this another way, it is desired to lower the energy/gross national product ratio for the U.S.

What factor can substitute for energy? To answer this question we turn to a model that several economists[9,10] have used to study factor substitution in U.S. manufacturing from 1947 to 1971. Here a production function is used which relates the maximum possible flow of gross output (Y) to the input services of capital (K), labor (L), energy (E), and other materials (M).

Expressed in symbols, the function is

$$Y = Y\ (K,\ L,\ E,\ M).$$

The emphasis of the work is the degree to which energy is substitutable with capital and labor. A measure called the elasticity of substitution, σ_{ek} (in this case between energy and capital) is defined, and has the meaning

$$\sigma_{ek} = \frac{\varepsilon_{ek}}{M_k}$$

where ε_{ek} is the cross price elasticity between energy and capital, or the percentage change in the quantity demanded of energy for a 1% change in the price of capital. The market cost share of capital M_k is found from the production function Y which is conveniently expressed as a logarithmic function. Similar elasticities of substitution can be found between the other inputs.

The results from one investigation, that by Berndt and Wood, are given in Table 1.

<u>Table 1</u>

Substitution Elasticities

	Labor	Energy	Materials
Capital	1.01	-3.53	0.49
Labor		0.68	0.61
Energy			0.75

The result of note is that energy and capital have a negative elasticity of substitution so that instead of being substitutes, they are complements. In other words increasing the proportion of capital input also increased the proportion of energy input in U.S. manufacturing, 1947-1971.

This would appear to be in direct contradiction to a "common sense" engineering analysis which generally shows that to improve the energy efficiency of a device and thus use less energy, a greater amount of capital has to be invested. How can these views be compatible?

In later work,[11] Berndt and Wood have suggested that within the K, L, E, M grouping, capital and energy can be viewed as a pair. From 1947 to 1971 the price of labor increased more rapidly than any other factor. Manufacturers responded by substituting capital and energy for labor, that is, having machines take a greater proportion of the work in manufacturing. According to Berndt and Wood then, energy and capital moved together in a complementary fashion, and were both substitutable with labor. Total production grew during this time, and this effect over-rode the direct substitution of capital for energy to achieve either energy efficiency or capital efficiency; whichever may have been desired.

Table 2 shows the movement of the proportions of capital, labor, energy, and materials in 1947 and again in 1971. Total output for U.S. manufacturing Y is given in gross billions of dollars.

Table 2

Year	Y	K/Y	L/Y	E/Y	M/Y
1947	196.2	0.047	0.230	0.040	0.613
1971	458.0	0.056	0.150	0.039	0.574

Note that the input-output coefficient for labor has dropped from 0.230 to 0.150. There have been several government strategies during this time which have brought this circumstance about. One is the effective lowering of the cost of capital through investment tax credits, liberalized depreciation (which allows less tax to be paid because capital stock may be written off more quickly) and accounting legislation which enables deductions from earnings to be made for interest payments on capital, again resulting in less tax. Energy also became cheaper in real terms from 1947 to 1971.

The price of labor on the other hand increased during this period because of employer contributions to Social Security schemes, and rising incomes to workers in real terms.

These movements occurred at a time when the government was keen to stimulate investment and economic growth, and when the amount of energy consumed was not of concern either for economic or political reasons.

As with all econometric analysis which relies on historical data, the Berndt-Wood result does not say anything explicitly about the future. But it does raise an issue of just how effective are moves to substitute energy with capital, which is one of the principal conservation initiatives of the National Energy Plan.

If the move to substitute energy with capital (by lowering the price of the energy efficient capital equipment) is taking place in an environment of general stimulation of capital investment and generally expensive labor, then the conservation achieved is likely to be masked by the trend toward energy using capital equipment. Putting this another way, even though the conservation investment tax credit may increase the efficiency of use of energy in a particular application by encouraging the purchase of a more efficient device, if there is a persistent government tax policy which encourages the substitution of labor with machinery, the conservation investment tax credit will have a limited effect.

From 1947 to 1971, there was a steady movement toward mechanization in industry. Farming, for example, requires a much greater input of capital and energy relative to labor today than was the case in 1947. If it is government policy to conserve energy as a matter of national importance, then a greater employment of labor, that is, a reversal of the historical trend, will assist that goal. If the price of labor was to fall relative to capital or energy through, say, wage subsidies rather than additional capital subsidies, or by increasing the real price of energy, employers will respond by buying more labor and less energy using machinery.

Since 1973, the price of energy has risen in real terms, and the response of industry has been to reduce the investment rate in capital and energy. The Vice President of Manufacturers Hanover Trust noted in 1977 that "over the past three years it has become more expensive to increase capacity by adding machinery and equipment than it has by adding workers". Thus an energy policy which raises the price of energy relative to labor will in the long run assist the dual goals of energy saving and full employment. There is also the implication that stimulating investment through generally lowering the cost of capital will work against the goals of energy conservation.

The 1978 Budget proposals contained several measures which impact on this discussion of energy conservation and employment. These are as follows:

(1) Maintain or increase present investment tax credits and accelerated depreciation provisions in corporate taxation.

(2) Maintain the corporate employment tax credit (initiated in 1977 by HR 3447) which gives a credit for

new employees hired; and maintain the Comprehensive Employment Training Act.

(3) A personal income tax reduction to stimulate employment through increased purchases of consumer goods and housing.

(4) Continued growth in State and Federal conservation programs.

The first set of policies, item (1), stimulate investment and employment in the short run, and in the long run increase energy use and reduce employment. Chapman[13] points out that the capital subsidies have a "decumulation" effect on employment. The immediate effect over a few years is to increase construction and new equipment activity, increase employment, and raise total output. However, as the substitution studies show, the long run effect is less employment.

Item (2) can be expected to promote both employment and income. While the credit was not designed to assist with energy conservation, it is working in the direction to assist the substitution of capital and energy with labor.

The impact of a personal income reduction (item (3)) will depend in part upon the simultaneous path of energy prices. Petroleum product prices have been declining in real terms since 1974. However, suppose energy prices resume their inevitable growth. Then the positive effect on consumer demand of a tax reduction must work against the negative effect on demand of higher energy prices.

Item (4) will promote both employment and energy conservation. Conservation programs are usually labor intensive; for example, manufacturing and installing insulation requires a greater component of labor than of capital, energy, or other materials.

To conclude this section, we return to the possibility of wage subsidies as a means of fighting unemployment and promoting energy conservation. Such subsidies would provide compensation for the biases or distortions presently in factor prices arising from the investment tax credit and the payroll tax financing for Social Security. An employee's take home pay would remain the same, and the wage subsidy would be paid to the employer, whose wage bill would thus drop. However, while the investment tax credit (introduced by the Kennedy Administration in the 1960's) is considered sound economic policy, the wage subsidy, a similar device in many ways, is viewed as a radical departure.

We will go on to discuss the effect of the conservation investment tax credit and will make the point that it will probably have a minor impact on actually reducing energy consumption. In view of this and the importance of stimulating conservation, it would seem that wage subsidies could be an important policy tool to be considered.

2.2 The Relationship Between Energy Efficiency and Capital Cost

What do we mean precisely when we say that capital can substitute for energy? And is there any evidence that consumers choose between the two?

In answer to the first question we mean that increased energy efficieny in a building or machine always entails greater capital cost and that more of one means less of the other.[12] To obtain greater efficiency in a turbogenerator, higher temperatures and pressures must be used which mean better burners, thicker pressure vessels and improved control systems. Better energy efficiency in a home, or less heat loss, implies installing insulation, storm windows and so on. District heating schemes to utilize the waste heat from power stations have very high capital cost.

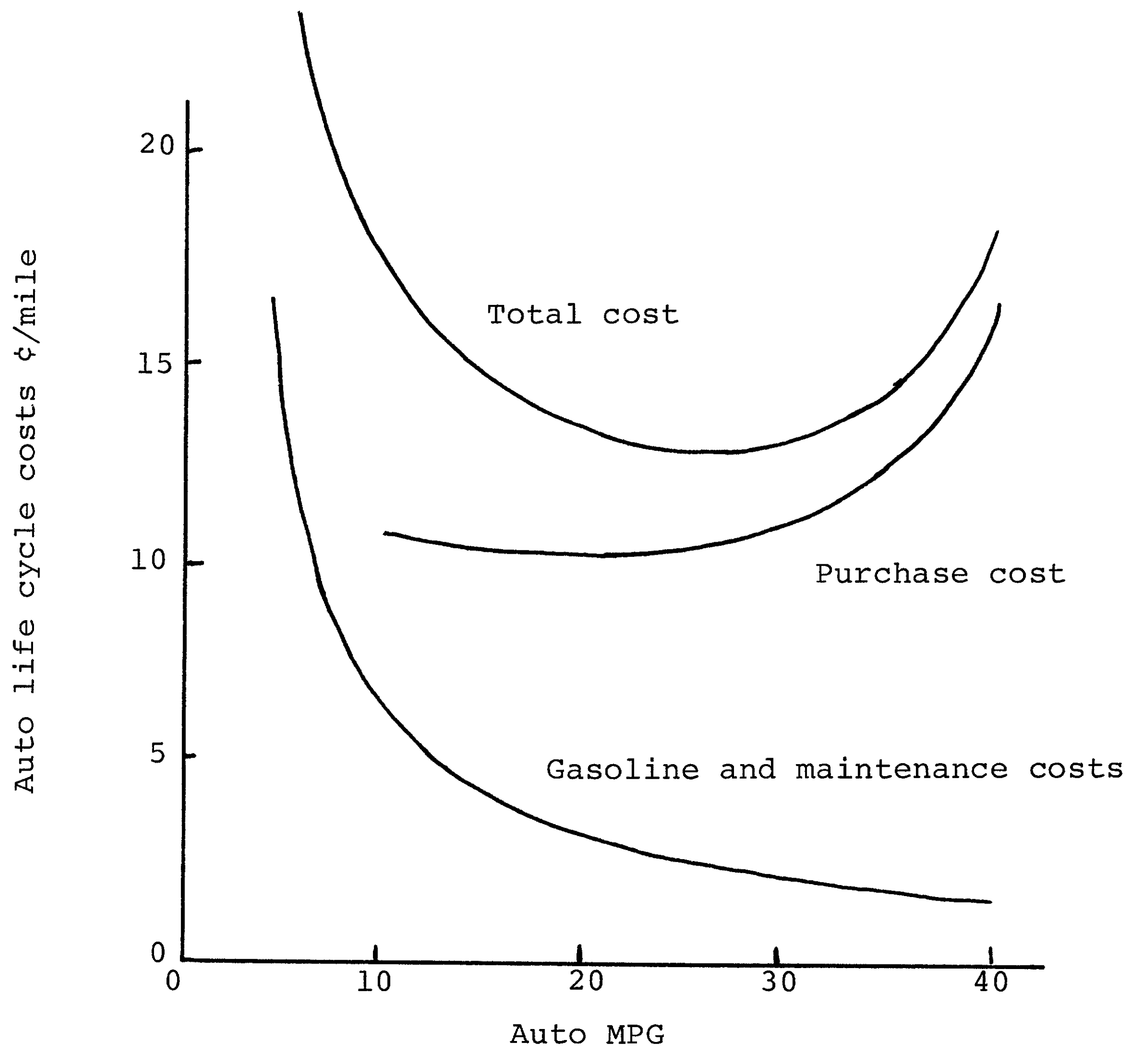
The National Academy of Sciences[14] gives a graph for the capital and running costs for automobiles, which is reproduced as figure 1.1, and the tradeoff can be seen: a minimum cost point is obtained in cars of about 25 miles per gallon. There is now a wide range of airconditioners and refrigerators available on the market and again here, increasing efficiency means greater capital cost.

Thus consumers do in fact make a tradeoff between the two factors. For some years, however, the tradeoff has been dominated by the capital cost. This is because efficiencies and running costs have not been well labeled, and consumers have been uncertain of the future price of energy and hence of what payback period or discount rate is appropriate.

It is one of the stated aims of the National Energy Plan to make policies and prices 'predictable' so that the uncertainty regarding payback on an efficient device is removed. One of the effects of this will be to lower the required rate of return on the investment for an efficient device, and to place more weight on the energy component of cost.

In summary, for a particular application it is possible to conserve energy by greater investment. The warning from the microeconomic studies described in the previous section is that to conserve energy as a national policy, fiscal measures which are designed to stimulate capital investment generally will tend to counteract measures to encourage the replacement of energy inefficient devices by more efficient and expensive ones.

Figure 1.1 CAPITAL AND ENERGY COSTS IN AUTOMOBILE TRAVEL



Purchase cost rises for high mpg cars because small cars generally have shorter life than large cars, so the life cycle costs are higher.

Note the substitution of investment cost for energy cost.

3. Methods of Government Intervention

3.1 Summary of Strategies

There are three levels at which the government can intervene in energy demand; to the fuel itself, to the end-use device, or to the consumer. Within these three levels nearly all initiatives can be classified as one of six broad strategies.[15,16]

(a) Pricing policy. Energy prices would be either allowed to rise to market levels through decontrol of prices, or there would be taxes on the fuel (i.e. a BTU tax) to bring the price to desired levels. Consumer response to higher prices would be relied on to cut demand.

(b) Supply restriction or allocation. Energy supply would be restricted to a fixed level and some nonmarket allocation would be used to distribute the available supplies.

(c) Regulatory and legislative provisions. Constraints and standards would be placed on the way energy is used, and on the devices themselves to the extent economically desirable.

(d) Incentives and tax provisions. Incentives, usually tax credits or subsidies, would be given for energy efficient forms of production or consumption. Disincentives, in the form of taxes, would be placed on inefficient devices.

(e) Technology development. The government would fund research, development, and demonstration of energy conservation technologies.

(f) Information-related laws and strategies. Consumers would be made aware of the economic advantages of conservation to themselves, and would be urged to change, in the national interest, any wasteful habits.

In this categorization, strategies (a) and (d) aim to alter the relative price of energy and capital; the former by raising the price of energy and the latter by lowering the price of capital. Initiatives (b) and (c) are achieved by government fiat, and essentially interfere with a free market, while strategy (f) attempts to correct a market deficiency.

In summary, the five conservation strategies listed earlier boil down to two kinds: those that simply facilitate more rational behavior in response to given market forces (or more informed energy-use decisions), and those that attempt to improve the allocative function of the market place. This could be done by setting prices that reflect social (or external) as well as nominal costs of energy production and distribution systems.

We may illustrate these categories by examples drawn from the National Energy Plan.

3.2 Pricing Policy

The first version of the National Energy Plan proposed to raise prices of oil and gas as much as it was judged politically viable. This was to be through a wellhead tax on oil and natural gas which would bring prices up to world levels in three years. Old oil and gas would be taxed to prevent producers collecting "excessive" profit. Additional taxes on the use of oil and gas in industry were intended to stimulate a switch to coal. Also, electricity pricing was to be overhauled with a view to marginal cost pricing and the elimination of promotional rates that give discounts to large users.

What would be the effects of these taxes which would raise the price of most petroleum prices by 7 cents per gallon in 3 years, amounting to a 12% rise. Sweeney[7] has estimated that in the short run, 1.2% less gasoline would be used for a 10% increase in cost, but in the long run (as people buy new cars) demand would decrease 7.3%. Thus phasing the tax in over a period of time will have the effect of avoiding a sudden dislocation in price, but will send the correct signal to consumers.

Putting up the price of oil to stimulate the switch to coal would push up the price of the latter if the industry does not have spare capacity to respond to the increased demand. A switch of the magnitude hoped for by the Administration (690 million tons to 1200 million tons per year) will extend the industry to its limit, and it is likely that the price of coal will be similar, in BTU terms, to the price of imported oil, less a transportation markup for the former.

3.3 Supply Restriction or Allocation

While there are emergency plans for rationing oil in the U.S., the National Energy Plan does not consider supply restriction as a means of reducing imports. It is an expensive program to administer, and is open to fraud and manipulation.

To prevent prices rising to unacceptable levels if supply to the market was restricted without corresponding price controls, some form of non-market allocation or rationing is needed. Careful priorities of supply must be defined, and questions such as the right of resale of the allocation decided.

3.4 Regulatory and Legislative Provisions

There are many regulatory strategies both already in effect and proposed by the National Energy Plan. In the transportation sector the most well-known provisions are the 55 mile-per-hour speed limit on highways, and the mandatory automobile efficiency standards. The latter may eventually take the form of an outright ban on fuel-inefficient cars. In the building sector there is a requirement that regulated utilities advise on request the energy savings possible in their consumers' homes, and assist them in arranging such measures. Federal home finance corporations would provide a market for capital to finance the investment. Efficiency standards are set for all new buildings to come into effect in 1980, and existing federal buildings will be upgraded. In the home appliance sector minimum performance standards would be set and appropriate labeling instituted for furnaces, air conditioners, water heaters and refrigerators.

These regulations will have the effect of encouraging the gradual replacement of the present stock of appliances and vehicles with more efficient ones. As such they will generally be inflationary in that capital costs will rise except perhaps for cars.

Regulatory strategies are sometimes no "fairer" or progressive than price strategies. The 55 mile per hour speed limit applies equally to all consumers and the vehicle efficiency standards would alter the availability but not necessarily the price of large cars. So the lower income person who needs a large car for either business or family is not unnecessarily penalized. The same is not true for houses, however, where the cost is increased to both the wealthy and poor.

3.5 Incentives and Tax Provisions

All the incentive strategies in the National Energy Plan are aimed at lowering the capital cost of devices which can reduce the demand for oil. There are also disincentives which raise the capital cost of devices which are considered wasteful or inefficient. The provisions of the Plan include taxes on cars with low fuel efficiency and rebates on efficient cars. There is a tax credit for the installation of insulation in a home or business, and a large tax credit where alternative energy sources - such as solar energy equipment and cogeneration of electricity and steam - are installed. A tax credit is provided for industrial conversion to coal, and a grant program for schools and hospitals conservation financing. In the transportation sector there are incentives for electric cars, and subsidies for mass transit to lower the costs of the latter relative to automobiles.

We will discuss the effectiveness of the investment tax credit at length in the following section. The credit aims to improve the rate of return on investments in conservation, to tip the scales in the mind of the investor. It has the ambitious aim, by 1985, of bringing 90 percent of the buildings up to minimum standards for insulation, to install solar energy in 21 million homes, and to reduce gasoline consumption to 10 percent below the 1977 level.

3.6 Technology Development

A significant component of government energy research funding in energy is directed toward "demonstration projects" in which a commercial-sized version of the venture is constructed and capabilities demonstrated. However, it is not always clear that such projects will improve the commercial prospects of a technology unless so much knowledge is gained from the project that the technology becomes cost effective and self-sustaining in the market. But if this were so, a firm would usually take the initiative itself because of the prospect of high returns from the investment.

In the field of energy conservation, the National Energy Plan provides for only one specific development and demonstration initiative; district heating installations at large government nuclear research establishments. Outside the Plan, however, there is ongoing research and development in such fields as more efficient automotive engines, electric power transmission and operation, and improved industrial energy conversion systems.

3.7 Information Related Laws and Strategies

The rapidly rising price of energy is probably the most persuasive reason for a consumer to become aware of the possibilities for conservation. But because a consumer has to make a capital expenditure in the present to obtain a stream of future benefits, the concept of life-cycle costing and discount rates is involved. Unfamiliarity with these concepts could lead consumers to put off making a decision. Thus to correct what is essentially a market deficiency, the government should direct some of its efforts toward educating and informing homeowners and businesses of conservation economics. In addition to this, a government may feel that by informing loyal citizens of the problem in the national budget brought about by importation of oil, it can urge them to change their lifestyles a little to use less energy and reduce the national deficit. Such advertising will shake the "slack" out of the system to some extent, but is likely to produce limited results after that.

Initiatives proposed in the National Energy Plan are mainly towards energy labeling of appliances. Automobiles are already tested and labeled for their fuel efficiency, and this is now one of the principal benchmarks many motorists use. Another option open to the government is the example that can be set to the public through the use of government buildings and cars. In these latter two areas, federal buildings must be modified so that they use 20 percent less energy from 1975 levels, and government cars must be such as to obtain 4 miles per gallon better than the national average fuel economy by 1980.

4. The Effect of the Conservation Tax Credit

4.1 A Policy Initiative

A principal initiative in the National Energy Plan is a tax credit for expenditures on insulating and other energy conserving materials. The incentive is a direct 20% tax credit for residential expenditure and a 10% investment tax credit for industrial and commercial conservation investment. It is available through 1984 for the former and 1982 for the latter. The objective of this measure is to lower the effective cost of, say, insulation, so that the apparent rate of return to the owner is improved. From a more general economic point of view, it is desired to lower the price of capital stock relative to energy, to encourage a substitution of capital (investment in insulation) for energy (losses through walls).

4.2 The Response of a Business

For a business the decision on whether to invest in energy conservation measures is a good deal more complex than that for a residence because of taxation requirements, and disparities in rates of return for various energy-related investments. We wish to analyze here the effect of the investment tax credit, and whether it is a viable device for promoting energy conservation through a switch away from energy.

The benefits from a conservation investment V_o can be regarded as periodic cash flows $C_1, C_2 \ldots C_n$. Given a discount rate or "internal rate of return", i, the net present value at period k, NPV_k, can be calculated from

$$NPV_k = -V_o + \sum_{j=1}^{k} \frac{Cj}{(1+i)^j}$$

The benefit stream C_j has the following components for each year j.

$$C_j = \Delta Ce(1-y)_j + \Delta D(y)_j + ITCc + ITCs$$

The term $\Delta Ce(1-y)$ represents the savings in energy (or operating) cost, ΔCe. Since this is expensed before tax calculations are made (i.e. it is deducted from gross profit), profits go up, because the output is being produced for less input. Hence tax payments increase by the amount $y\Delta Ce$ where y is the income tax rate, and the total benefit is $\Delta Ce(1-y)$.

The term $y\Delta D$ recognizes the fact that the capital investment of the firm has increased, so depreciation expenses have also increased by ΔD. Hence the stated profits of the firm have decreased, and tax payments diminished by the amount $y\Delta D$. Liberalized or accelerated depreciation allows an initial write-off of nearly double the straight line expense for long term investments, and this method is often used by businesses to reduce their stated profit in the near term. In this analysis we will use linear depreciation, which is also widely employed.

Note that the investment tax credit due to conservation ITCc is in addition to the standard investment tax credit ITCs, but they are received only in the initial period.

Not included in this analysis is any tax shield arising from the source of funds. If the investment is funded by debt, then interest payments can be expensed. However, in practice it is difficult to reflect this in the rate of return calculation as clearly the capitalization of a firm is not wholly debt. The installation would probably be funded with a mixture of debt and equity to preserve the debt ratios. In general, the particular financing arrangements in a company should be factored into the analysis as appropriate. Also not included is the possible salvage value of conservation hardware at the end of its useful life. This will probably be small, and its present value can be neglected.

Suppose we take as an example a capital expenditure of $10,000 in energy conservation that reduces energy costs by $2000 in the first year. Current dollars will be used in this analysis, and we assume that the cost of energy increases at an average rate of 10% per year. (Under the NEP crude oil equalization tax, this will be the case till after 1980). Suppose the write-off period is 10 years, that linear depreciation is used, and that corporate income tax is 50%. Further, suppose that a conservation investment tax credit of 10% is available in addition to the standard investment tax credit of 10%. Then the cash flows for the lifetime of the investment are as follows:

Year	ITC Tax Credit	$\Delta Ce(1-y)$ Energy Saving	$\Delta D.Y$ Depreciation	C_j Total
1	2000	1000	500	3500
2		1100	500	1600
3		1210	500	1710
4		1331	500	1831
5		1464	500	1964
6		1610	500	2110
7		1771	500	2271
8		1949	500	2449
9		2144	500	2644
10		2358	500	2858

The internal rate of return from this cash flow, using the net present value relationship, is <u>18.6%</u>.

If the $1000 tax credit from the conservation investment is <u>not</u> available, then the initial year's benefits drop to $2500, all other cash flows staying the same. In this case the internal rate of return is <u>16.3%</u>. In this example then, the investment tax credit for conservation has done little to improve the rate of return.

There are a range of conservation measures that, instead of taking five years to pay back on a straight dollar basis, may take <u>three</u> years. In the above example the first year energy saving becomes $3333, reduced to $1667 because of taxation. Again assuming a 10% inflation on energy prices the internal rate of return with the conservation investment tax credit is 29.5%, and without it is 26.9%.

If the dollar payback takes only two years, then the internal rates of return are 41% and 38% respectively.

It can be seen in this simple example that the conservation investment tax credit has a minor effect in improving the rate of return on an investment. The important factors are the payback time, and the expected inflation in energy prices.

The question that must be addressed is: what rate of return does a firm investing in conservation expenditures require? Recently the Massachusetts Energy Policy Office[17] surveyed various firms about their attitude to conservation investment. They found that firms required a rapid payback, often within a few years, because of uncertainty over energy price. Industry generally expects a higher rate of return on cost saving investments (such as energy conservation) than on investments in plant expansion or in other measures to increase productivity. The latter is viewed as being of primary importance to a company in maintaining its competitive position. At least a 25% rate of return is generally required for conservation investments compared to about 15% for "production" investments. The investment tax credit is aimed toward closing this differential.

The Massachusetts Energy Policy Office study also showed that there has been a trend towards more capital and energy intensive investment decisions in industry, and this trend has existed even since 1973. Because the price of labor - until 1973 - increased more rapidly than both capital and energy, there has been a substitution of labor by capital and energy together (i.e. machines using energy). The effect of the investment tax credit is to widen the price differential between labor and capital still further, and enhance the substitution, other factor prices staying constant. Working against this however is the increasing price of energy. The effective reduction in the cost of capital (i.e. improvement in the rate of return on investment) is about 12% (18.6% to 16.3%). The expected increase in energy prices roughly balances this at 10%. So a possible response is that energy will substitute for capital, but the two together will continue to substitute for labor. The latter will, of course, reduce the effectiveness of the conservation investment tax credit as a policy initiative.

Another disparity in rates of return on energy related investments exists which works against conservation investment. A utility has a regulated rate of return on its rate base of approximately 10 percent. Against this, a company or business investing in a power plant such as cogeneration or solar energy requires a rate of return of at least 15 percent. Thus investments to expand supply are made with a considerable advantage over those to reduce demand, and this is especially so in the electricity utility industry. The conservation investment tax credit is aimed toward closing this differential, but the effect will be to close it only a few percentage points.

A firm requires a high rate of return on energy conversion devices such as cogeneration and solar energy because they are viewed as being risky investments. The technology is young and immature and is undergoing rapid change, so a firm will require rapid payback so that their device does not become dated too quickly, or give costly operating problems. There is also uncertainty as to the future of such devices, because of unpredictable government policy in energy pricing and regulations.

There are considerable institutional barriers in the path of cogeneration installation that must still be addressed. We give just one example which is concerned with rates of return, the main subject of this section. A large firm may be always able to utilize all the steam and electricity from a cogeneration device. However a smaller firm may be unable to do this, and may wish to export electricity to the grid in order to fully utilize the equipment and maintain their rate of return high. But if they generate electricity for export they may become a regulated utility, with rates of return held down, and the costly regulatory framework of rate hearings. The reverse situation, in which a firm usually supplies its own electricity but requires standby power from the grid in the event of machine failure also has to be resolved. In this case the firm may have to pay for the capital costs of its share of the spare generating capacity, so it ends up by paying twice for the capacity; once for the cogeneration facility and again for the spare capacity.

In addition to the investment tax credit improving the rate of return for devices such as cogeneration and solar energy, legislation aimed at removing institutional barriers will lower the required rate of return to a business. As the market for the devices builds up, encouraged by the removal of uncertainty, the required rate of return will drop further, both to a business purchasing the device and to the investor in a firm making them.

4.3 Response of the Residential Sector

Now let us look at the effect of the conservation tax credit on a homeowner or tenant. A homeowner will need to find out the potential savings through conservation in his house. He would first complete an energy audit of his house, and the calculation would look something like the following.

Suppose the house area is 1200 square feet, and it is located in the Boston suburban climate with 6500 degree-days per year of heating required. The homeowner is considering having installed 6 inches of cellulose insulation in the roof at a cost of $400. (The walls should also be "audited".) The only formula he needs to know relates the "R value" or quality index of the insulation to the climate and size of roof.

U value = 1/R

= BTU's transmitted per square foot per hour, for every degree fahrenheit temperature difference between the two sides of the surface.

The "surface transmittance" in BTU/yr. is defined as U x degree-hours per year x square feet of surface.

	Without Insulation	With Insulation
R value	5	35
U value	0.2	0.0286
Surface transmittance	37.4×10^6	5.35×10^6
Savings (BTU/yr.)		32×10^6

The price of one million BTU delivered is approximately \$3.50, and if the furnace is 85% efficient this is equivalent to \$4.12. The savings per year are \$132.

Thus on a straight dollar payback basis, the homeowner will need about 3 years to recover the cost.

If we make the same assumptions regarding energy costs and lifetime as for a business (10% increase in price per year and 10 year lifetime) the internal rate of return on this investment is 40%. For constant energy costs over 10 years the rate of return is 30%. The investment tax credit for conservation effectively reduces the cost of the insulation by 20%. If the latter was \$300 and the installation cost was \$100, the total cost is reduced to \$340. The internal rate of return is now improved to 46%. (37% at constant energy prices.)

Note that the investment tax credit for conservation does not lower the perceived cost of insulation directly, instead it reduces a homeowner's total tax liability. The effect of the credit is felt at tax payment time and is progressive since it allows a tax-free amount of expenditure.

Are these returns sufficient to encourage a homeowner to invest in conservation? Baron et al[19] found that for oil and gas consumption in Massachusetts the elasticities of demand assuming various rates of return were as given in the following table:

	Elasticity Assumed Rate of Return		
	4%	8%	12%
Oil	-0.27	-0.26	-0.14
Gas	-0.27	-0.18	-0.17

These were calculated from deriving "technological demand functions" for the housing stock of Massachusetts, and one such function is given in figure 4.1. The demand curve is a step function with the length of each step being equal to the amount of fuel conserved by each investment (e.g. storm door, storm windows, insulation in roof and walls, new forced hot water system). The height of each step is equal to the change of price of fuel necessary to produce a particular technology investment.

TECHNOLOGICAL DEMAND FUNCTION FOR RESIDENTIAL OIL CONSUMPTION

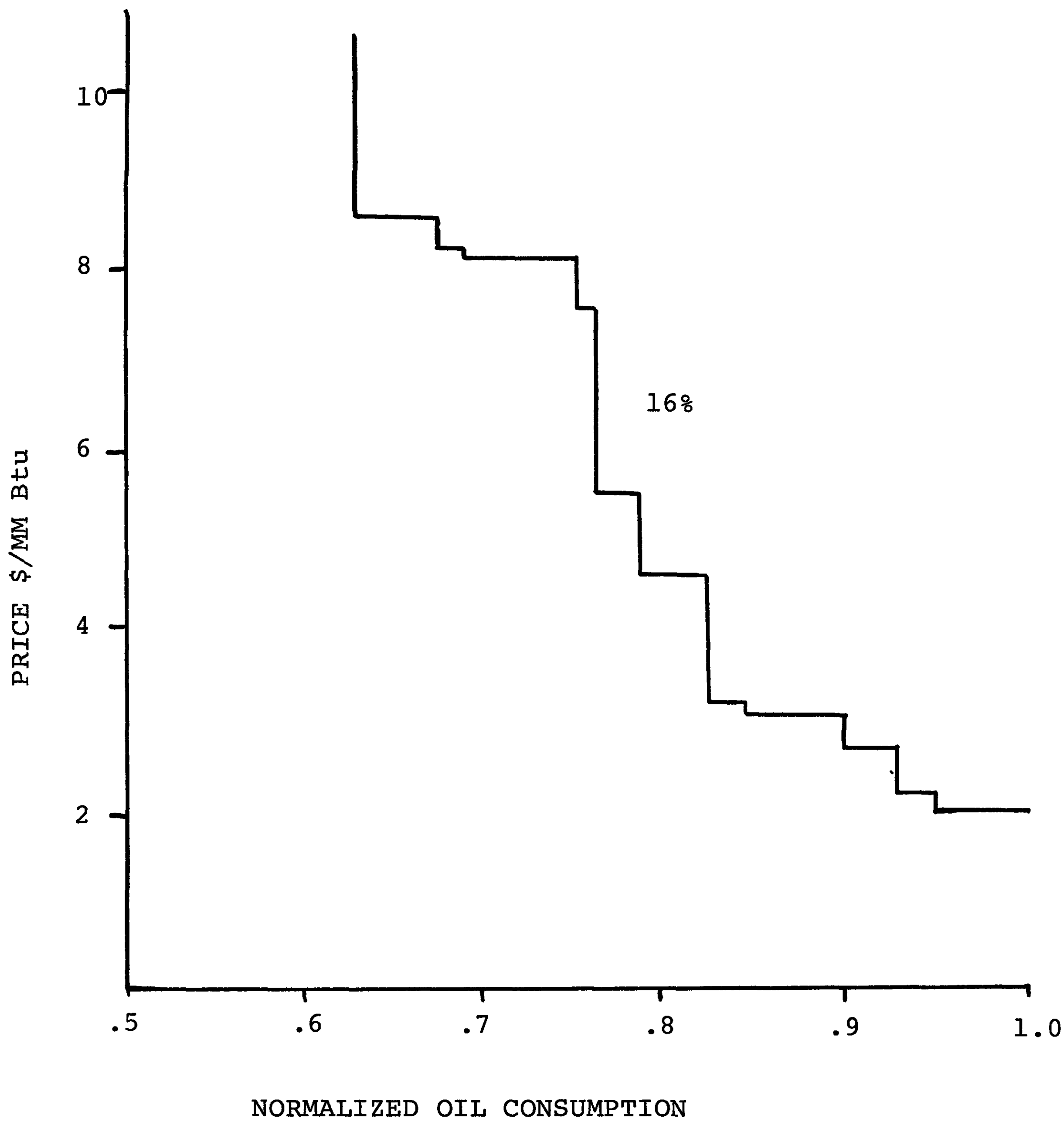


Figure 4.1

While this study assumed constant energy prices in current dollars (i.e., falling in real terms) it showed that when a rate of return of 16% was required by householders, there was still a significant reduction in energy demand. The calculation given for the 1200 square foot house shows that much higher rates of return are available to people who have not to date insulated their houses even in the unlikely event of constant energy prices over the next decade. It is also apparent that the investment tax credit for conservation has not "tipped the scales", and that people who have not insulated their houses to date are simply unaware of the savings available.

A way of looking at the credit is that it is a "sales pitch" for conservation, and may make consumers feel that they do not have to lower their standard of living in order to conserve energy. They may feel that conservation is on 'sale' and that they are getting a bargain if they take advantage of the tax credit. It could be, in fact, that the effect of the tax credit, and the publicity associated with it, will be to bridge the communication gap and overcome the psychological barrier.

It is probably this communication gap that accounts for the observation that homeowners "need" a very high rate of return before they will invest in conservation. One reason sometimes advanced for the high return needed is the relatively high turnover of housing in the U.S. A homeowner would like a rate of return of 40% if he thinks he may be moving in 5 years and is not sure that the price of the house when he sells will reflect the value added by the insulation. This has never been empirically demonstrated however. Another reason suggested for the high rate of return required by homeowners is the higher interest rate demanded by institutions when they lend to homeowners rather than corporations; with the implication that this is a market failure that needs to be corrected. There is of course a good reason for the higher interest rate; namely that homeowners are more risky to lend to than corporations. In any case the difference is only a few percentage points, and does not really explain the tens of percentage points representing the apparent rate of return.

The foregoing discussion has applied to people living in their own homes. What is the effect of the conservation investment tax credit on landlords and tenants? The credit is available to them both, so either can take the initiative.

The answer largely depends on whether the cost of heating is included in the rent, and whether, if the building is multi-unit, apartments are individually metered.

If heating costs are included in the rent, then it is in the landlords interest to install the insulation, because if he maintains the rent at the previous level he will benefit from the same rate of return as a home occupied by its owner. Tenants will only benefit if the landlord forgoes some of his extra earnings.

However, if the lease provides for the tenant to pay for heating (or a proportion of it if the building is several apartments) the landlord has no incentive to invest in conservation since he will not benefit. The tenants are unlikely to invest since they do not own the building. Even if they have obtained permission from the landlord they will wish to be sure of recovering their outlay so presumably only long-term tenants will invest. Since insulation is a "social good" to tenants in a building, it is conceivable that one tenant could refuse to participate when he hears all his neighbors are planning to insulate the roof, knowing that he will collect the benefit anyway. The only mitigating circumstance is that in a seller's market for accommodations, energy efficiency can become a feature point for an apartment, which could induce the landlord to install conservation even if his tenants pay for heating.

In summary, renters will be subsidising homeowners to the extent of the tax credit. Since homeowners are often wealthier than tenants, the interpretation is that the credits are regressive.

Another of the tax provisions that applies to residences is that there is a tax credit for solar and wind equipment, amounting to 30% of the first $1500 and 20% of the next $8500, available through 1984. This is a sizeable credit, but its effectiveness is to some extent offset by the fact that the price of heating oil (and gas) is explicitly controlled at a level about 10% below the cost of oil sold for other purposes.

The substitution of capital for energy is likely to occur more slowly under such circumstances and if the motivation is to protect low income groups, it may be preferable to increase welfare payments rather than maintain the price of home heating oil at a relatively low level.

While insulation, weatherstripping, and so on, certainly reduces energy waste, it is not clear that total energy consumption will go down by the amount of waste that is prevented. The experience of New Zealand, which has had an incentive program for home insulation in place for some years, is that higher income families predominantly have taken advantage of the scheme, and that they tend to live at higher temperatures (in winter) than before.

Another marginal effect of installing insulation is that it will lower the total (life-cycle) costs of running a house. Hence, because single family dwellings use more energy, their total cost will fall relative to apartments. At the margin then, more single family dwellings would be built, all other factors being constant. But since these use more energy than apartments (because of the lack of shared walls), the effect on reducing energy consumption could be partly offset.

There are other examples which can be invoked to illustrate the notion that where there is a tax credit or a subsidy aimed at lowering the price of capital relative to energy, and energy prices themselves are stable, consumers may take the opportunity to increase their standard of living rather than reduce energy consumption per se. The real incentive for conservation investment comes from the expectation of a loss of income due to rising energy prices.

The latter situation has been the case since 1973, when consumers have been responding to higher prices by installing insulation and weatherizing their homes. Sales of insulation material have tripled since 1973 and some analysts have questioned whether the tax credit is needed because of this obvious response. There is normally a long response lag between a fuel price rise and the decision to install insulation or solar heating. For people who have already made such a decision, a large proportion of the investment tax credit will be a <u>windfall payment</u> that is an unnecessary inducement. It is clear, however, that this response has come from homeowners who have sufficient capital to purchase the insulation. In the presence of the tax credit, more homeowners may be induced to invest, it would seem that the overall effect will be to reduce inefficiency and also consumption. Hirst and Carney[6] in their analysis of Federal programs predict that "the programs authorized by the U.S. Congress or proposed by President Carter (appliance efficiency standards, thermal standards for new construction, retrofit program) will save large amounts of energy for the Nation and money for households". But two important reasons for the reduction in demand mentioned in their paper were felt to be appliance saturation and declining population growth rather than the substitution of energy for capital.

4.4 The Manufacturers of Conservation Materials

The conservation investment tax credit, to the extent that it affects investment decisions, will stimulate demand for insulation, storm windows, improved burners in furnaces, and so on. The increased demand will, in the short term, move prices upward on such materials until manufacturers expand their production facilities and bring more products onto the market.

But what will happen if the tax credit is short term, and known to be so? Suppose the tax credit is available for four years starting from the present, but that it takes a manufacturer four years to expand his production and distribution facilities. Then the manufacturer will be concerned that, when the tax credit is removed, demand for the product may drop at just the time that he is ready to cope with a bigger demand! In this case rather than embark on the full expansion he may opt for a partial expansion, and maintain the high price. Economic rent will accrue to the manufacturer which will not be used to eventually expand production facilities, and the investment tax credit is effectively passed through the homeowner or business to the manufacturer.

Thus, there is a danger in short-term investment tax credits in that they may not provide sufficient incentive to manufacturers of conservation hardware to expand their production facilities. They may not bring about a behavioral change in the market. It would seem essential that, to be effective, the tax credit must be available for a sufficient time to enable production facility expansion to completed, and the market to adjust accordingly.

The implicit assumption in the National Energy Plan is that, by 1985, energy prices will rise relative to those for capital so that the ratio between the two will be same as that pertaining when the tax credit was in effect. If this happens there will be stable markets for conservation manufacturers and the possibilities outlined above will not occur. Such price trajectories cannot be predicted with certainty in advance, but it does seem likely that energy prices will rise relative to the other factor inputs, and that the assumption is justified.

4.5 The Response of Utilities

We have seen that the investment tax credit is designed to encourage a homeowner or business to invest in conservation and decentralized energy supply technologies. To the extent that demand for oil, gas, and electricity drops, a utility or oil company will have reduced or deferred some incremental construction expenditure. A capital expenditure will have been made instead by the consumer. Thus stimulation of conservation is characterized by a gradual shift in capital stock from the supply sector to the demand sector.

The question arises as to whether there are any impediments to this process taking place, such as discrimination in the access to capital, or monopoly control by the utilities. Further, should some form of explicit capital transfer be encouraged through legislation?

There seems to be no evidence of monopoly control by the supply industries, since there is already a rapidly growing market in conservation investment. Indeed it would seem that it is presently in the utilities interest to encourage this shift in capital stock.

The electricity utility industry is currently facing a period of potential shortages of electrical capacity, especially in the southeast. There are two principal reasons for this: delays in the present construction program due to environmental and regulatory pressures, and an unwillingness to invest in new plants because rates of return are regulated at levels which make it difficult to raise the necessary amount of capital without diluting existing stock (by selling new stock below book value). This shortage of capacity will manifest itself through reserve margins (or spare capacity over demand) falling to critically low levels in the early 1980's. Spare capacity in a power system is needed to cater for both planned outage and forced outage (or failure of generating sets and power lines). If plant margins drop below about 16% in a thermal power system, brownouts and unreliable electricity supply will result.

In such a situation, some utilities are finding that it is in their interest to fund conservation in their client's residences and businesses. Although in theory, the costs of extra generating capacity can be added to the rate base and recovered, stockholders are reluctant to see this happen if the value of their stock will diminish (or be "diluted"). One utility in the northeast, for example,[18] has been supplying bathroom shower flow restrictors to its customers free of charge. These reduce shower water consumption by 45%. By calculating the load at peak contributed by electric hot water heaters, and the reduction in total hot water use effected by the restrictors, and dividing the cost of the program by the reduction in peak, a figure of $116/KW results. The capital cost of peaking capacity that would otherwise have been constructed in, say, 1986 is $280.

Another example is in the Pacific Northwest. In the utility systems here, including the Bonneville Power Administration, radical increases in costs of new thermal generation and unexpected delays in licensing and authorization of new plants have caused potential shortages of capacity. Legislation (HR 9020) is proposed that mandates conservation through appropriate building and usage standards. Up to $300 million dollars at any time shall be made available for programs, grants and loans (including interest-free loans) to enable conservation to take the place of capacity that cannot be completed on time. For many electric companies in the northeast, standards for house insulation must be complied with before electric space heating is installed. The objective is to minimize waste and the building of unnecessary power plants.

The situation is more complex in the natural gas supply industry. The price of interstate gas is regulated at a level below that of the free intrastate market, so to maintain the rate of return on an interstate pipeline, it is necessary to keep the line as fully loaded as possible. It would be against the interest of the pipeline companies to reduce demand in the short run. The supply companies on the other hand face declining reserves of gas, and the argument could be made that to maintain their market share, it could be in their interest to fund customer conservation rather than finance exploration for expensive new gas. They may wish to keep prices down to maintain their market share and hence the strength of the company and its political power. The segmentation of the industry makes this strategy difficult however.

The issue that has not been adequately addressed however in current energy legislation is how the average homeowner with generally limited funds will be able to afford the capital cost of conservation. With many homeowners, conservation investment is still a low priority item compared to education, health and leisure. If a government is serious about conservation as a national goal, it must make funds easy to obtain for homeowners. Some form of guaranteed loan at low interest rates would go far in overcoming this problem.

5. Energy Taxes and Higher Prices

5.1 The Effect of Higher Energy Prices

The previous chapter discussed incentives as a means of stimulating the substitution of, firstly, capital (i.e. conservation investment) and secondly, other energy forms, for oil and gas. The other major economic strategy in conservation is the pricing of energy itself, particularly oil and gas, to encourage the two substitutions, and to reduce demand for the fuels.

If the price of a commodity goes up because of increasing demand, consumers generally respond by using less of the commodity. The classic microeconomic "income and substitution" effect takes place.

Suppose capital were to be substituted for energy if the price of the latter were to rise. (There could also be a substitution of labor.) Then in figure 5.1, A-B represents the substitution effect, and B-C the income effect. The income effect tends to be seen in the short-run as consumption habits are changed. Less energy is used because effective income has dropped. The substitution effect is more long-run, as time is taken for the capital stock to change, e.g. more efficient cars to be bought, or insulation to be installed.

We may characterize the likely effect of a long run increase in energy prices relative to those of capital, labor and other materials as a three stage response.[20]

(a) Immediate. The primary response will be a reduction utilization rate of energy intensive devices. This means that thermostats will be turned down, cars run less, and lighting levels reduced; although it is obvious that in many cases, response will be limited.

(b) Short to medium term. There will be several responses measurable in a time span of weeks or months. Firstly there would be a reduction in demand for energy intensive goods and services, resulting in gradual improvement of energy efficiency. Secondly, there would be substitution of other factors of production such as capital (to the extent that energy use is actually decreased, such as insulation) and labor.

(c) Long term. There would be further substitution for energy as the old capital stock is retired (i.e. new machines and cars purchased) and more energy-efficient devices are purchased. There will also be technological change to bring new devices to the market place, which will enhance the possibilities for substitution. The rate of adjustment is influenced by federal taxation policy which can determine depreciation rates and investment decisions.

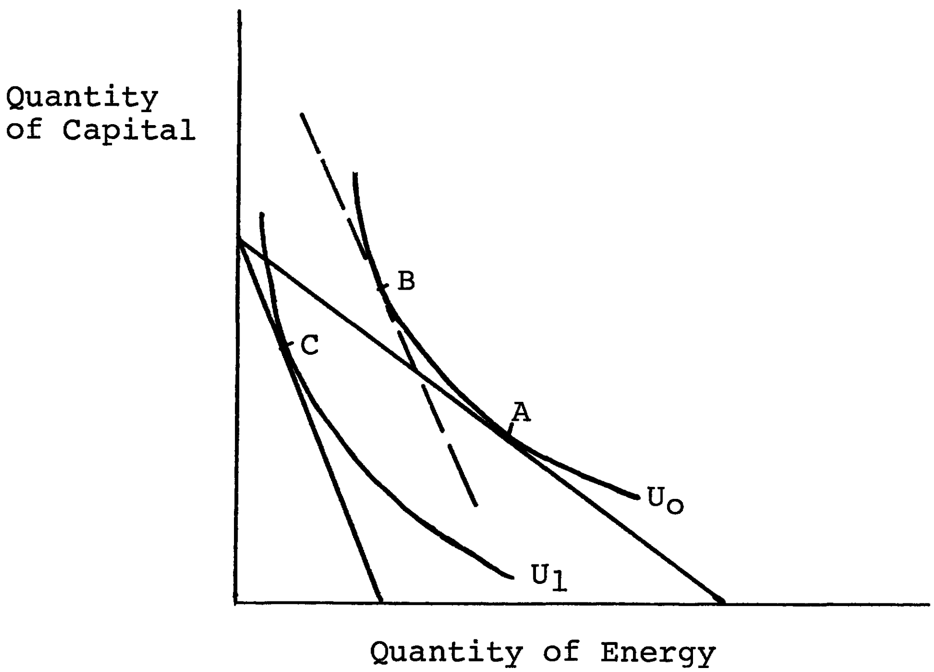
Figure 5.1

The Income and Substitution Effect

A → B Substitution effect

B → C Income effect

Price rise in energy represented in shift of curve U_o to U_1



There is ample evidence that this process was taking place before the advent of the National Energy Plan. The reason is the rapidly rising price of energy relative to other factors which has occurred since 1973.

An unprecedented transformation has begun in conditions affecting supply and cost of energy in the United States, and the world. Its most salient feature is a shift from a situation in which increasing production of energy resulted in lower costs of production to a situation in which new increments in production lead to higher and steadily increasing costs. The result of this is that marginal price is presently higher than average price, the opposite of the situation pertaining in the U.S. before 1973.

There has begun an inexorable march of energy prices. The order to begin was given in 1973 by the OPEC cartel, and while the late 1970's will see a slackening of the pace, the drum that will be heard in the late 1980's will be scarcity of the resource.

But if higher prices are inevitable, why should we be interested in taxing energy still further? Indeed, present government policy is to hold the price of energy down as much as possible. The main reason is to try to "phase-in" higher prices by taxes now, rather than wait until scarcity could increase them much more rapidly. We may represent this situation diagramatically in figure 5.2. Increasing demand curves for 1975 and 1985 are shown. The single supply curve with rapidly increasing slope means that, for the time interval represented in the diagram, there are no radical changes in technology and the marginal cost of winning new energy increases rapidly after 1985.

The NEP predicts that, if there were no energy conservation instituted in the near future, the economy would settle at equilibrium point I; being the intersection of the 1985 demand curve D1985 and the supply curve S. The fear is that, because of the rapid consumption of oil and the long lead times in bringing in new technologies, the supply curve will exhibit escalating price beyond 1990.

The aim of the NEP is to affect both the supply and demand curves. Firstly, the effect of the six initiatives described in chapter 3, from taxes to education, is to move the demand curve to the left; that is to say, to cause less energy to be demanded for the same price. It is desired to reduce the demand for energy below the previous market clearing quantity. Thus, a new demand curve for 1985, $D1985^{c}$, would replace D1985. Also, the NEP provides for new oil to be priced at the marginal cost, and the effect of this is to raise the supply curve to S^{c}. The same total quantity of oil would cost more. This effect is not large in the immediate future, as the new price is "rolled-in" to the old price.

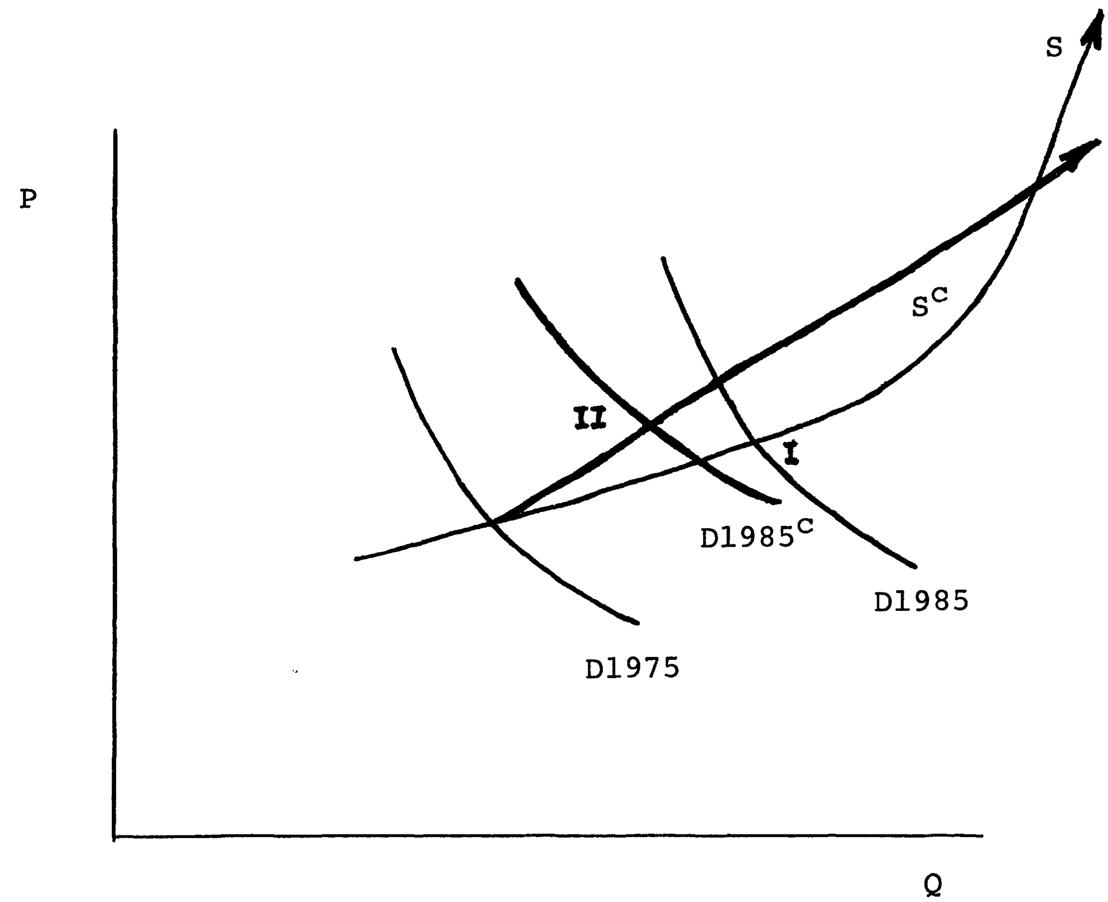
However, since the pressure on depleting resources is relieved somewhat, the new supply curve S^c does not, it is hoped, exhibit the same rapidly rising characteristic as the previous curve S. The new supply and demand curves are the heavy lines and the new equilibrium point is shown at II. One could argue whether the D1985 curve has the same slope as $D1985^c$, and we have shown it with slightly higher elasticity because the aim of conservation initiatives is to improve consumer education and market response.

As was pointed out in chapter one, it is very difficult to predict an unambiguous base case of "business as usual". For example, one analysis contends that the NEP has understated the trends toward higher prices, conservation, and the switch to coal; and that these trends could outpace the program itself. While it is difficult to see this happening without the abandonment of federal control of energy prices and the movement to free market pricing of energy, it is true that the plan capitalizes on trends already well established in society.

But why is it the will of Congress to hold energy prices down? The first reason is that Congress wishes the public to have the benefit of the surplus generated by the relatively lower price of domestic production compared to imports. If domestic oil sold at the price of imports and was untaxed,

Figure 5.2

Effect of NEP on Demand and Supply of Energy



then producers would collect the revenue; and if it were taxed the government would collect. Over the past few years it has been desired to prevent both these eventualities, although the NEP has now proposed that the latter become the new policy. The second reason is doubt that extra large supplies of oil and gas would be forthcoming even if prices were to rise. The third and most fundamental reason is a desire to protect the lower-income groups. Rising energy price has a regressive effect; it hits poorer people harder.

It can be argued, as in Musgrave's approach to public finance, that distribution problems are really separate from allocation problems, and that it is more efficient to deal with income distribution issues directly by increasing the income of poor people through such means as a negative income tax or family allowance. Programs to hold down a price subsidize rich consumers as well as poor consumers.

Brannon[22] comments that "The issues connected with Musgrave's solution are basically political. If we follow a policy of permitting a high market price for energy, how are those concerned with the poor to know that an appropriate measure to increase the income of the poor will in fact be made? If there is a trade-off between a high energy price program and some income program such as an improvement in welfare, how do we know that the welfare improvement is more than a mere one-time anticipation of a welfare adjustment for inflation that would have come next year anyway."

However it does now seem inevitable that energy prices must rise. Both new technologies such as synthetic fuel, and decentralized technologies such as solar energy will only become competitive with prices 50-100 percent above present levels. Yet while it is desired to bring in these technologies to ease the drain of revenue to the oil producing countries, the immediate pressure on the world oil price is probably down, because of the high flow of oil to the market from Alaska, the North Sea and the prospective Mexican fields.

To ease the necessary transition to less convenient energy forms than oil, and the corresponding higher prices, a "phasing-in" period of taxes is required. Sooner or later the adjustment to higher prices must be made, as has occurred in nearly every other country in the world. To avoid sudden and disruptive effects to the economy, the change should be gradual and it must be consistent to provide the market with the correct signals.

When the long lead times for the development of new energy supply technologies is recognized, the concept of pricing oil at its "replacement cost" is useful. A supply technology such as synthetic fuel (either from shale, coal liquification, or biomass) will take decades to grow to the situation of having a significant market share. Opening mines (together with the environmental clearances and labor resources that are required) and building synthetic fuel plants and transportation networks are time consuming and expensive.

Suppose that oil is priced simply at the marginal cost of primary and secondary recovery. As more expensive recovery methods become necessary to satisfy the demand, the price will begin to rise, and will do so until the synthetic fuel technologies become competitive. But suppose now that the depletion rate for crude oil is faster than the rate of introduction of synthetic fuel, due to the long lead times of the latter. Then price will rise rapidly as more money is spent in an effort to short cut the lead time. The price will "overshoot" the level at which it would have stabilized if the lead times for the syn-fuel technologies had been allowed for.

There are two ways to prevent this phenomenom. The first is to subsidize the newer technology to make it appear cheaper than it really is. The second is to phase in a higher price through taxes so that the newer technologies are encouraged through the market mechanism. The inevitable price rise is thus smoothly anticipated without overshoot or market distortion.

Such taxes also promote economic efficiency, because some technology other than additional liquid fuel may be brought onto the market. If some conservation strategy or solar energy becomes competitive during the phasing-in period, it will attain a market share and reduce demand for the syn-fuel. This would not have happened if the synthetic fuel had been subsidized, or oil had not been taxed at its "replacement cost".

As well as taxes to shape demand, many countries use energy taxes to raise government revenue as fiscal measures. Inside the U.S., this is a controversial practice, and the only revenue gained from energy taxes is used directly in assistance to the way the energy is used, for example, the limited gasoline tax is used in maintaining roads.

There are three main types of taxes on energy: product taxes, tariffs, and a general energy (or BTU) tax. A fourth type of tax, on machines or appliances, is proxy for an energy tax. We will discuss each of these briefly although the product tax and the equipment tax were the only initiatives proposed in the National Energy Plan.

5.2 Energy Tax Policies

The most important product tax in many countries is the gasoline tax. The private automobile is a very heavy user of fuel, and has many externalities associated with it, such as atmospheric pollution, injury, and urban disruption. A result of the U.S. taxation pattern is a preponderance of heavy vehicles on the roads compared to the light, fuel-efficient cars in Europe.

In the U.S. it appears to be more politically acceptable to regulate people out of big cars than to tax them out. Because of the mandatory fuel efficiency standards, the numbers of large cars will dwindle, and the fuel efficiency average for new cars by 1985 will be 27.5 mpg. It has been estimated that the average fuel efficiency in 1985 will be 22 mpg.[23] If we take the long run price elasticity of gasoline to be -0.75 and the present fleet average to be 15 mpg, the regulations have had the same effect on the purchase of new vehicles as putting up the price by 62 percent. However, there is no effect at all on the driving habits of people presently owning large cars. It is likely that the response would be small even if the price were to be put up, since the short run price elasticity has been estimated at only -0.12.

Product taxes, since they are selective on fuel type, encourage switching away from one fuel to another. Thus the NEP uses this device extensively to tax industrial oil and gas in order to stimulate the switch to coal.

A second type of energy tax, and one that does not have a selective effect in encouraging fuel substitution, is a general energy (or BTU) tax. A BTU of energy would be taxed, rather than the tax being calculated from the price of the BTU. The tax could be applied either to the producer or the retailer, but from the point of view of ease of administration it would be the former. The effect, if we consider petroleum taxes as an example, will be to increase the price of all petroleum derived products. Since it may be undesirable to do this across the board (in plastics for example) there will probably be complicated exceptions. The wellhead tax on oil is a type of BTU tax because although applying to petroleum only, it increases the price of all products of petroleum.

The third form of energy tax is a tariff on imported oil. Tariffs have the advantage that they stimulate domestic production, and it would raise energy prices even more than the presently disputed option of raising the domestic price up to the world price through the wellhead tax.

Conclusion

Energy conservation has sometimes been viewed in the negative context of restrictions on activities or reduction in economic growth. In fact, the reverse is true.

Conservation involves extensive research and development, new and diversified manufacturing processes, and a large labor-intensive industry in installing the materials. It means economic ingenuity in choosing the right investment, and engineering knowledge to devise new processes.

While it is true that rising energy prices alone will act to reduce economic growth, the conservation response will counteract this to a large extent. The development, manufacture and marketing of conservation technology is an area of real growth in the economy. A theme of this paper is that gross output of the economy will continue to grow if labor is substituted for capital and energy at the margin. The relentless pursuit after automation and labor-saving devices in the U.S. could thus be slowed down with beneficial effects in a time of rising energy prices.

The coservation investment tax credit will enhance the positive growth aspects of the conservation industry. While saving a possibly limited amount of energy, it will create new industries with new jobs and expertise. This industry should be in a position to supply the materials that will be in greater demand when energy prices rise still further during the next decade.

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